



## MOLECULAR DESIGN AND EVALUATION OF CO<sub>2</sub> ADSORBENTS

### Background

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Capture/separation of carbon dioxide (CO<sub>2</sub>) has been identified as a high-priority topic within the carbon sequestration program. The costs of separation and capture, including compression to the required pressure for the storage step, are generally estimated to be a significant percentage of the total cost of the sequestration scheme. Improvement in CO<sub>2</sub> separation and capture will reduce the total cost required for sequestration.

The objective of this project is to develop novel amine-enriched sorbents for the capture of CO<sub>2</sub> from flue gas streams generated by the utility industry. These novel CO<sub>2</sub> capture sorbents will be prepared by the chemical treatment of the high surface materials with various amine compounds. The implanting of amine groups on the high surface area material will increase the needed contact area between CO<sub>2</sub> and amine by several magnitudes. Therefore, only a small amount of sorbent used in the typical amine process is needed for capturing the same amount of CO<sub>2</sub>. A significant improvement of the efficiency of the process is due to the increased contact area and therefore less energy consumption in regenerating the sorbents.

### Primary Project Goal

The research is aimed to incorporate and graft the amino-functionality onto various high surface substrates for the capture of CO<sub>2</sub> from flue gas streams produced by the combustion of coal. These sorbents must be regenerable, durable and cost effective to create a CO<sub>2</sub> capture system which can be used in the utility industry.



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## Objectives

Major objectives are to:

- Design a sorbent that will bind CO<sub>2</sub> at greater than 3 moles CO<sub>2</sub> per Kg of support; ideally greater than 5 moles CO<sub>2</sub>/kg of support
- Allow for binding temperatures between 55 and 75 °C
- Allow for CO<sub>2</sub> release at temperatures less than 120 °C, where release is complete in less than 1 hour
- Provide for a low pressure drop across adsorbent bed
- Allow for binding at gas flow rates and with gas mixtures (up to 8 percent water, 14 percent CO<sub>2</sub>, 50 ppm SO<sub>x</sub>, 25 ppm NO<sub>x</sub>) that are industrially realistic
- Provide the information to develop a new environmental control technology for the reduction of the carbon dioxide greenhouse gas emission

## Accomplishments

The atmospheric pressure performance of these amino-sorbents was obtained in a temperature swing adsorption (TSA) system after exposed to a 10 percent CO<sub>2</sub>/2 percent H<sub>2</sub>O/He experimental gas stream. Their ability to capture CO<sub>2</sub> over the temperature of 25-65 °C was detailed. After the adsorption stage, the desorption of CO<sub>2</sub> from these sorbents was determined at 90 °C and the sorbents were regenerated for additional cycles. According to the TSA/mass spectrometer analysis, all of the sorbents were successful in the capture of CO<sub>2</sub> from the moist experimental gas streams. The best performing sorbents are summarized in the table.

Sorbent Type	Researchers	Temperature °C	Mole CO <sub>2</sub> /Kg Adsorbent
Immobilized	NETL/ U. of Hartford	25-65	2.5-4.0
Synthetic	NETL/ U. of Pittsburgh	25-65	2.0-3.0
Polymeric	NETL/ Ga. Technology	25-65	4.0-5.5